

MEMORANDUM ON THE EFFECTS OF TOURIST TRAFFIC ON PLANT LIFE,  
PARTICULARLY BIG TREES, SEQUOIA NATIONAL PARK, CALIFORNIA  
MAY 13 - 16, 1926

E. P. Meinecke, Pathologist,  
Office of Investigations in Forest Pathology,  
Bureau of Plant Industry.



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At the request made to District Forester, P. C. Redington by Mr. Stephen Mather, Director, National Park Service, on November 4 the undersigned visited the Sequoia National Park May 13-16<sup>1926</sup> for the purpose of studying the possible effects of intensive camping and heavy foot travel on the trees of the Park. The assistance given in a generous measure by Colonel J. R. White, Superintendent of the Park, has helped materially in the analysis of existing conditions.

If the main object involved in the setting aside of National Parks is the preservation, in their natural state, of selected regions of outstanding beauty or interest, then it must be recognized that the sins of past generations have left their indelible marks and have already modified natural conditions to a greater or lesser extent. This is particularly true in Parks of the type of the Sequoia where the principal objects of interest and beauty are the Big Trees and the forest vegetation associated with them.

The community of Big Trees, and particularly its oldest representatives, stand in a class by themselves. They are irreplaceable within a period going far beyond human reckoning. How long they will live if undisturbed cannot be guessed at, but the underlying object of any protective measure must undoubtedly be the prolongation of their life not for one or two generations but for centuries. In actual practice, the means to be employed must aim at minimizing and counteracting the injuries and unfavorable conditions inherited from the past and the prevention of further damage. Since the basic constitution of the parks more



or less precludes direct measures, both remedial and preventive action must be predominantly indirect.

Any attempt to render the attractions of the Park accessible to the public inevitably conflicts with the maintenance, in the natural state, of the Park as a biotic unit. It is assumed, for the following discussion, that the administrative measures flowing from the resulting compromise between the two aims are guided by the principle of preservation rather than by that of attracting the greatest possible number of visitors. The larger the transient population of the Park the more difficult will be the task of protecting wild plant life from injury and disturbance.

The problem of striking a practicable middle course is complicated by the fact that the largest Big Trees, as the outstanding assets of the Park, have reached an age far beyond their prime and by the difficulty of controlling an ever growing enthusiastic but unconsciously predatory population of visitors. The solution of the problem rests upon an understanding of the physiology and condition of the trees as individuals and members of the forest community and upon an analysis of tourist psychology and behavior.

It must be remembered that the very trees which make for the beauty of the Park are not the young and vigorous saplings and poles or even younger standards. These the tourist finds everywhere in the mountain forests. The chief interest lies in that class of large and picturesque trees which are approaching the end of a long life. Their growth is slow and their recuperative power is not what it was in the time of their youth. For many centuries they have been exposed to the cumulative effect of adverse factors such as fire, heavy storms and lightning, fungus diseases and insects. The invasion



the  
of/Forest by man following the colonization of California has added another factor of outstanding importance to the list of factors injurious to tree life.

The Park trees are protected against fire and the cutter's axe, and heavy lightning, the only other cause of actual destruction is fortunately rare. The great majority has survived, though has not overcome, the manifold handicaps they have grown up under. After all, man has only had a relatively very short time to work havoc in, as measured by the great age of the Sequoias. A tree will adjust itself to adverse factors if given a fair chance. This adjustment is of necessity a slow process and is possible only within certain limits. If injury is heaped upon injury even so remarkably hardy a species as Big Tree must decline and succumb. The greatest danger comes from the cumulative effect of injuries and the constant interference with vital functions through man.

The tree takes its water from the soil, moves it upward in the sapwood and utilizes a part of it in the manufacture of food in the foliage. This food then travels down in the living bark to the last ramifications of the root system, feeding the mantle of living tissues all along the way. Keeping in a certain ratio to the development of the crown the root system spreads farther and farther in the soil. Big Tree is fairly shallow-rooted and the roots of older trees often extend to 40 and 50 feet from the base, always keeping relatively close to the surface. It is a general rule that such roots are very sensitive to any change in the surface level and in the depth and character of the soil which covers them, such as is brought about by the cumulative effect of foot or vehicle travel around them, by trail and road construction or the erection of buildings over the area



occupied by the roots. Since the enormous water requirements of the tree can be satisfied only through perfect functioning of the root system any serious and lasting disturbance must lead to a water shortage in the budget of the individual which in turn affects the crown and its food producing power. The entire problem of the preservation of the trees is therefore intimately tied up with the thought and care bestowed upon the root system. The actual water intake is a function of the very ends of the roots which must be fed by the products of the crown conducted downward in the living bark. The older parts serve merely to anchor the tree in the soil and to conduct the water from the root tips to the trunk. They are far less sensitive to changes in the soil than the root tips. Consequently, the region to be protected more carefully against such changes is not the immediate vicinity around the tree base but rather the circumference of the root spread. Compacting of the soil through tourist travel does most harm at the outer belt of the root system.

The inner belt nearer the tree base also has its vulnerable points. Wherever one of the older roots comes close to the surface it is exposed to wounding on its upper side through man, vehicles or saddlehorses. The living bark is worn off and the sapwood of the root which conducts the water upward lies open to sun and wind. The affected portion dies and is no longer capable to function as a part of the water system. Furthermore, the affected portions of the living bark is eliminated from the system which transports food from the crown to the roots and keeps them in functioning condition. An individual injury of this type may not be a serious matter, since by far the greater part of the sapwood of the root is imbedded in the



ground and remains sound. When a number of roots are wounded in this manner or when the root functions are handicapped in other ways the collective damage is likely to find its expression in a toning down of the activities of the crown.

A similar and more consequential injury to the tree comes from the habit of many tourists to climb up upon the buttresses and burl like growth at the base of many of the oldest trees. All the water conducting elements from the innumerable roots come together at the base of tree and merge into the mantle of living sapwood of the trunk which is protected only by the bark. In this relatively thin mantle the entire water-lifting machinery is located. Its thickness is regulated according to the specific water requirements of the individual. The constant and oft-repeated abrasion of the bark caused by the clambering tourist finally destroys the living bark with the elements which transport food to the roots, and exposes and kills large parts of the sapwood which are thereby eliminated from the water conducting system. Normal self-healing through callus formation is made impossible as long as the tourists have free access to the base of the tree. The healing-tissues are destroyed as soon as formed.

An individual injury of this type on an old Big Tree struggling for existence is bad enough in itself though perhaps not fatal. The serious nature of the wounding lies in the fact that similar injuries are frequently made all around the base. Taken together they often reduce the living mantle to half and even less of the normal. The tree must then adjust its water budget to the much reduced amount which can be pumped up through the remaining living tissues. It is burdened with an additional, and undoubtedly serious, handicap.



When trees congregate to form the society which we call forest they enter into mutual relationships. Competition for soil space and soil water, for crown space and light comes into play from an early age and generally culminates in the domination of the stand by a selected number of individuals to the detriment of the rest. In this struggle the Big Trees easily have the best of the associated species. But life in the forest society brings with it an advantage enjoyed by all trees, including Sequoia. Standing together the whole mass of trees forms a solid body on which storm winds have little hold. From this system of mutual protection the shallow rooted Big Trees benefit perhaps even more than their associates. Any opening practiced in the body of the forest in road building or in the clearing of camp sites forms an entering wedge for heavy winds. Even if the Big Trees themselves are not in danger of being thrown their lower and rather brittle limbs become exposed to wind breakage. Associated trees may suffer even more seriously and in falling may widen the gap in the forest.

While insects have not been recorded as causing serious and lasting injury decay is far more prevalent in Big Trees than is usually accepted. Since decay affects only the dead heartwood except where large wounds have laid the sapwood bare it is not noticeable in the standing tree. The fungus causing the decay has not yet been determined. The rot is characterized by long vertical pockets in the wood, filled with rough cubes of a brown charcoal like mass. The life of the tree itself is not endangered except insofar as it becomes mechanically weakened and when fire eats deeply into a trunk containing this decay the pockets offer far better fuel than the surrounding firm wood.



The well-known goosepens so common in Big Tree are the result of this burning out of the portion of the butt afflicted with decay. When the latter reaches high up into the bole the fire may burn out a complete chimney through the bole of the tree without destroying the shell of sound heartwood and sapwood. In extreme cases the shell is so thin that it is killed by the heat. In any event, the tree is weakened to such an extent that it may no longer resist the onslaught of heavy winds.

#### Present condition of Big Trees

The Big Trees came under the protection of the Park Service after they had been exposed to the ravages of forest fires, lightning, storms and decay for many centuries. Of these four main factors only forest fires have been eliminated, but they have left their indelible and in many cases most profound scars. The large base burns so common on all of our forest trees are familiar to everyone. Considered in the light of their bearing on the life of the tree they reduce the normal circumference of normally water- and food-conducting wood and living bark. Less conspicuous but of similar import are numerous smaller base burns, frequently hidden from view by over-hanging callus formations. Only the remaining healthy bridges of living bark and sapwood make an exchange of water and foodstuffs between the trunk and the root system possible. The entire life of the tree depends upon the functioning of these connecting passages.

Few of the Big Trees have escaped fire injury. In the majority the live or effective connections have been more or less materially reduced. A rough attempt has been made to express in per cents the remaining extent of apparently effective connections, taking the entire circumference at the base as one hundred. Even a casual



observation establishes that the per cent of effective connections is reflected in the condition of the crown. The smaller the connection the poorer the crown condition. A few examples are given:

| <u>Tree</u>     | <u>Total circum-<br/>ference at base</u> | <u>Effective<br/>connections</u> | <u>Condition of<br/>crown</u> |
|-----------------|--|----------------------------------|-------------------------------|
| Unnamed tree    | 98'                                      | 30                               | poor                          |
| General Sherman | 135'                                     | 36                               | fair                          |
| Unnamed tree    | 100'                                     | 23                               | fair                          |
| " "             | 103'                                     | 45                               | fair                          |
| " "             | 76'                                      | 33                               | fair                          |
| Roosevelt       | 72'                                      | 88                               | perfect                       |
| General Wood    | 72'                                      | 79                               | perfect                       |

In one tree with a very poor crown the effective connections were reduced to about 5 per cent. It stands to reason that in all cases where the individual is handicapped in one of its most vital points any additional burden may prove fatal.

Wherever the destruction wrought by past fires has not gone too far we may expect slow healing over and final recuperation, always provided that the patient is scrupulously protected against further disturbance and direct or indirect injury. The process is always a slow one and will take many years.

At the upper end of one of the meadows several good-sized Big Trees are dead and others nearby are plainly ailing. This group presents a good example of the effects of a change in the physical conditions under which the trees have grown up. Just below the ailing group two trees, probably wind thrown, have fallen across the meadow, forming a natural dam. The free flow of water is interrupted and the meadow above the dam has become marshy and unsuited to the specific requirements of Big Tree.



The advent of the white man in the Sequoia forests has undoubtedly retarded the recovery of many of the trees. On all buttressed specimens the effective connections have been further reduced by the multitudes of tourists. The bark hunter curio collectors have blenished many a veteran. Incessant travel by man, horses and vehicles have worn deep grooves around the more spectacular trees. Reproduction springing up near them is trampled out of existence and the ground for many feet in radius is compacted to a cement-like consistency.

One of the deplorable consequences of camping and long continued milling of tourists around selected favorites is the almost complete eradication of undergrowth. Even in so short a period as fifteen years a noticeable change has taken place. The thickets of reproduction standing with their fresh green against the red bark of the Big Trees and giving perspective to the towering masses of their trunks have dwindled to meager remnants. Their value goes far beyond the esthetic. As a protective ground cover, maintaining stable conditions in the soil and keeping it cool and fresh over the root spread of the Big Trees they form an integral part of the tree association. It is to be regretted that some of the most serious depredations have been committed, unthinkingly, in road-building. Large roots, vitally needed in an already reduced system, have been chopped off. Yards of soil now lie on top of the normal level or have been dug away to make a road bed. On steeper slopes the lowering of the level amounts to a drainage of the soil from which the root ends normally take their water.

In the early days it was natural that visitors should pitch their camps under the Big Trees. The result was again a compacting of the soil. Besides this change in the physical conditions,



the chemistry of the soil has been influenced by the accumulated ashes from countless camp fires. While small trees, shrubs and herbaceous plants which have their roots close to the surface will be the first ones to suffer from the accumulation of inorganic salts from the ashes the slow penetration of the salt solutions into the deeper soil must finally affect the roots of the Big Trees as well.

### Recommendations

Any suggestions for remedial measures must be based on the assumption that conditions in the Park are to be brought back as far as possible to what they were before the advent of the white man and that further disturbing factors are to be kept down to the lowest point compatible with the comfort and safety of visitors.

### Care of individual Big Trees

A relatively small number of the Big Trees in the Park is actually under the influence of man. The public selects for its visits certain outstanding or easily accessible trees only. An additional number is disturbed by road building. The rest lives its normal life as it has for centuries. The latter group, therefore, lies outside of our considerations.

The bigger the tree the greater is the desire of the tourist to make its acquaintance, whether he enters the grove from curiosity only or is moved by deeper feelings of admiration and reverence. The first group, and particularly children, will attempt to get as close to it as possible. The second more thoughtful group keeps at a distance. Both must be satisfied.

The first consideration is the preservation of the effective live connections between trunk and roots and from these the public



should be strictly kept away. If it is deemed necessary to provide an access to the trunk itself it should be managed where the public cannot do any harm, that is, wherever a large burn has severed the connections. The General Sherman may serve as an example. With an effective connection per cent of 36 it has two very large burns close together and a smaller one on the opposite side. There can be no harm in admitting the public to these burns as long as it is kept from the living parts. The present system of placing blocks in a circle around the base of the tree combined with a sign board requesting the public to remain outside is a step in the right direction. It does not affect the curious, however, and throws traffic back over the more sensitive outer ring of root-endings and into the sparse remains of natural reproduction. On one side a tongue of remaining reproduction extends closer to the base of the tree approaching an important effective connection. At present this group is being slowly whittled down and in the course of time it will disappear. The visitor coming to the tree subconsciously follows the easiest and the apparently indicated way, the way others have traveled before him. He will avoid dense thickets and overlook and trample down isolated individuals. For the same reason the members of the thicket standing on its fringe are not safe, unless some real or imagined obstacle or fence sets the group off plainly from the public lanes. The displacement of a few logs and fallen limbs or even of rocks so as to form an inconspicuous fence existing in the mentality of the visitor rather than in reality should go a long way to direct tourist travel into definite channels away from reproduction. Judicious liberation of young Sequoias from the oppression by White firs and even planting with seedlings to fill in gaps and to extend the group can only be regarded as steps towards a re-establishment of original conditions.



It will be more difficult to protect in a similar way the remaining effective connections. Deliberate outlining of areas now naked but expected in the course of time to be covered with reproduction and even planting may, for a time at least, appear to many as too artificial a measure. It is simply the price we have to pay for the neglect and mistakes of past generations. It goes without saying that discretion and judgment must govern such measures. In general it will be more advisable to extend existing groups towards the tree than to establish independent patches of reproduction. The main object to be kept in mind is invariably the protection of the effective connections. In actual practice, the conditions prevailing at the present time must be brought in line with the visualized effect. A careful study must precede the plan to be put into practice.

The general result of the scheme will, in the case of the General Sherman, give three lines of access to the base of the tree, leading to the three big burns. These lines, not necessary trails, between the present and expected bodies of reproduction should appear to the tourist as obviously intended for travel. This indirect method which is based on the mental reactions and behaviorism of the visitor has distinct advantages over the direct instructive or prohibitory sign board which introduces an element out of harmony with the spirit of the grove. Sign boards as a supplement to personal supervision are indispensable at the entrances to the Park, at headquarters and in camps. In the presence of the forest veterans they can be used only with the greatest discretion if at all. Man involuntarily shapes his behavior to accord with the atmosphere of his surroundings. The sign board degrades the sanctuary to a show place, and the Park visitors will invariably react to the change.



The measures proposed are largely of a preventive type. Even if they are carried into effect the recovery of the soil surrounding the tree will be slow. The ground level in a ring around the tree is still below the normal, and its surface is cemented to a hard sheet. An attempt to bring the soil level back to the supposedly level may do more harm than good unless done with discretion. It may be advisable to loosen the surface a little with a mattock to give winter-heaving a chance.

The plan outlined for the General Sherman applies equally to all other trees which are singled out and visited by the public. In every case a similar analysis of the tree's condition and immediate surroundings will lead to a definite plan of treatment. A systematic inventory of the relatively few individuals of this class together with the mode of procedure adopted for each case has the advantage that a clear-cut policy is thereby laid down and handed on to coming generations of guardians.

One of the most difficult problems is the treatment of those trees which either by their position in the present administrative site and the old camps or along the main roads are obviously living under a serious handicap.

The engineers of old paid little attention to the lasting injury that the ruthless cutting of main roots, changes in the soil level and continued heavy traffic must inflict upon the trees. Some of the finest trees, for example in front of the administrative buildings, are completely surrounded by roads on which practically all vehicle travel is concentrated.



The roads cannot now be retraced without excessive cost but it might be possible to regulate traffic in such a way that at least one side of the trees is relieved. In the improvement of existing roads as well as in the construction of new roads relatively slight deviations from the direct line will often serve either to rectify former mistakes or to prevent new damage.

The present policy of keeping the newer camps away from the Big Trees' association and directing them into the drier Yellow pine type is undoubtedly an important step in the right direction leading to the ultimate goal of removing all camping from the immediate vicinity of the Sequoias. The harm coming from heavy concentration of traffic is aggravated by the humanly excusable but none the less obnoxious attempts at beautification with the introduction of the very features the park has been created to exclude. The abandonment of the older camps under the Big Trees combined, in given cases, with a treatment such as outlined for the General Sherman will tend to restore natural conditions. Here also the use of the mattock in loosening up the compacted soil surface may be beneficial. Special attention should be called to the practice of disposing of accumulated trash and litter. The removal of the latter is in itself rather a detriment than a benefit. The reincorporation of dead vegetable material into the soil is an important factor in keeping tree growth in healthy condition. Whenever the litter has to be removed for reasons of appearance it should not be burned over that part of the soil which contains the feeding roots and care must be taken not to change the chemistry of the soil by scattering of the ashes.



Mention has been made of a group of dying Big Trees at the upper end of a meadow. It may be possible to relieve the situation by cutting an outlet through the down trees which are responsible for the stagnation in the meadow above. It will be advisable not to effect too radical and sudden a change. The best time will be in winter or spring.

The Big Trees are without doubt the outstanding feature of the Park but they are at their best only in the setting of the associated forest. The beauty of the virgin forest with its rich undergrowth as well as the luxuriant flora of the meadows have suffered badly wherever tourist traffic has been heavy over decades. In the camps, along trails and in the vicinity of favorite trees and points of interest small trees and flowering plants have been trampled under and are now, in places, almost completely eradicated. The camp situation is rapidly improving. The general plan suggested for the handling of traffic near the Big Trees promises slow and certain restoration of the original flora, and the more intensive supervision prevailing at these points in itself acts as an effective protection to plant life. The situation is different along trails. Here the tourists travel in small groups, the sense of restraint is weakened and plants are trod under foot and flowers picked with impunity. The quality of the trail itself has its bearing on the subject. A plain well built trail holds the average well-intentioned tourist to its track and few will leave it. The poorer, the less defined the trail the greater will be the tendency



to see new paths, and the result is a strip of ten to twenty feet in width indiscriminately used for travel and accordingly damaged in its plant life. Much injury is caused by visitors seeking short cuts down steep slopes to avoid tiresome zigzags. In trail planning much can be done to avoid this deplorable feature by intelligent choice of grade.

Few measures will add more to the permanent beauty of the Park and help to obliterate the traces of forest fires and human depredations than the care with which natural reproduction is fostered. The truly virgin forest does not consist of towering veterans alone. Trees of all ages, springing up under their protection, form an integral part of the whole. It may be questioned whether this fostering should go to the extent of helping out here and there with planting. Wherever the establishment of a protective ground cover is needed planting, exercised with due care and discretion, can only be beneficial. The fundamental and guiding principle must always be the probable effect on the health of the community and the restoration of the Park to its original incomparable beauty.

E. P. WEINECKE

Pathologist.